“Environmental Impacts of Fly Ash from Parli Thermal Power Plant, District, Beed (MS) with special reference to plants and humans”

SYNOPSIS

For Ph.D. Degree under the Faculty of Science and technology

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Synopsis

Abstract: Parli Thermal Power Plant is located at Parli Vaijnath in Beed district of Maharashtra. The power plant is one of the coal based power plants of Maharashtra State Power Generation Company. Parli Thermal Power Station is an operating power station of at least 750-megawatts (MW) in Parli, Maharashtra Pollution Control Board (MPCB) records revealed that the Parli Thermal Power Station has a capacity of 1,170 MW and generates 7,55,167 tonnes of ash a year. This proposed research aims to conduct an in-depth investigation into the effects of fly ash from the Parli Thermal Power Plant on human health, plant growth in the surrounding vicinity.

Introduction: The growing demand for energy has led to a significant expansion of thermal power plants globally, including the Parli Thermal Power Plant, which stands as a crucial contributor to the region's energy needs. While these power plants play a vital role in meeting electricity demands, they also generate substantial quantities of byproducts, one of which is fly ash. Fly ash, a fine particulate residue generated during the combustion of coal, poses potential environmental and health challenges due to its complex chemical composition and physical properties

The Parli Thermal Power Plant, located in close proximity to populated areas, generates a substantial amount of fly ash as a byproduct of coal combustion. Fly ash is known to contain various potentially harmful elements and compounds, which can pose significant risks to human health, plant growth.

Fly ash has been used as a soil ameliorant in agricultural fields for several decades (Adriano et al., 1978; Gupta et al., 2002; Nayak et al., 2015). Fly ash application often enhances soil nutrients and plant nutrient uptake, and increases the biomass of crops and crop yields (Ram et al., 2006; Ram et al., 2007; Aggarwal et al., 2009; Thind et al., 2012; Ukwattage et al., 2013). For example, Nayak et al. (2015) demonstrated that the rice grain and straw yield in the greenhouse are significantly increased by applying up to 20% of fly ash. A 3-year field experiment showed the grain yields of sunflower and maize are increased with about 49% (40 t ha^{-1}) fly ash application (Yeledhalli et al., 2008). However, some studies reported that fly ash application does not change or even suppresses plant growth, as fly ash contains toxic metal (loid)s that inhibit plant growth (Jala and Goyal, 2006;

Sharma and Kalra, 2006). Metal (loid)s accumulation could impair biochemical and physiological functions in plants and influence crop productivity (Shahid et al., 2015).

This proposed research endeavors to scrutinize the effects of fly ash emissions on various aspects of the environment, with a particular focus on human health, plant growth. By comprehensively understanding these effects, the research aims to contribute valuable insights that can inform regulatory decisions, mitigation strategies, and public awareness initiatives.

The statement of problem:

The proposed research aims to investigate the environmental and health impacts associated with the emission and deposition of fly ash from the Parli Thermal Power Plant. As an integral component of coal combustion, fly ash contains a range of potentially toxic substances, including heavy metals and trace elements, which can be released into the atmosphere and subsequently deposited onto soil and water bodies. This raises concerns about potential contamination of local ecosystems, the food chain, and adverse health effects on nearby communities. Despite regulations and efforts to manage fly ash, a comprehensive assessment of its actual impacts in the specific context of Parli Thermal Power Plant's emissions is lacking. Addressing this knowledge gap is essential for informed policy-making and mitigation strategies.

Hypothesis:

1. **Environmental Hypothesis:** The emissions of fly ash from the Parli Thermal Power Plant contribute to the contamination of nearby plants, soil and water bodies, and leading to alterations in the chemical composition of the environment and potential adverse effects on local ecosystems.
2. **Health Hypothesis:** Prolonged exposure to particulate matter containing heavy metals and trace elements from fly ash emissions is associated with increased health risks for individuals living in proximity to the Parli Thermal Power Plant, including respiratory and cardiovascular issues.
3. **Mitigation Hypothesis:** Effective fly ash management practices, such as controlled disposal and utilization in construction materials, can significantly reduce the environmental and health impacts of fly ash emissions from the Parli Thermal Power Plant, thereby minimizing potential risks to the surrounding communities.
4. **Community Awareness Hypothesis:** Increased awareness and education among the local population about the potential risks associated with fly ash emissions can lead to community-driven initiatives that advocate for improved emission controls and mitigation measures.

Review of literature:

Coal, currently the largest source of energy on earth, is used extensively in electricity generation in different countries (Nataly Echevarria Huaman & Xiu, Jun. 2014). Coal was formed over many years by dead plants through the process of coalification. Carbon, sulfur, oxygen, hydrogen, small amounts of nitrogen and some traces of heavy metals are the main components of coal. The burning of coal leads to the emission of poisonous gases with underlying health impacts and environmental problems (Clancy et al.; Katsouyanni et al., 2001, Gent et al., 2003). In coal combustion, the carbon, sulfur, and nitrogen react with oxygen and produce their respective oxides: carbon dioxide (CO2) and carbon monoxide (CO), sulfur dioxide (SO2) and sulfur trioxide (SO3), and nitrogen dioxide (NO2) and nitric oxide (NO), respectively. The emission of these gases has been correlated with many health problems directly and indirectly, including skin, cardiovascular, brain, blood and lung diseases, and different cancers (Badman and Jaffé, 1996, Cornell, 2016, Bascom et al., 1996, Kelsall et al., 1997, Health effects of outdoor air pollution. Committee of the Environmental and Occupational Health Assembly of the American Thoracic Society, 1996, Pope et al., 1995).

Heavy metals are indestructible chemical elements produced during the burning of fossil fuels. These heavy metals (lead (Pb), mercury (Hg), arsenic (As), cadmium (Cd), chromium (Cr), and antimony (Sb)) exist in trace amounts in coal. However, large amounts of post-combustion wastes were generated in the form of fly ash, bottom ash and slag within the power plant. Such heavy emissions of heavy metals into the air were then inhaled by humans and animals, and cause fatal diseases including cancers (Linak and Wendt, 1993, Fulekar and Dave, 1986, Chirenje and Ma, 1999, Jablonska et al.,

During coal combustion millions of tons of coal fly ash (CFA) and coal dust were emitted annually to contribute to the formation of PM, and, therefore, underlying risks to life expectancy (Clancy et al.,, Chen et al., 2004, Clancy et al., Miller et al., 2007). For instance, coal dust exposure in school going children culminated in respiratory symptoms (Brabin et al., 1994, Temple and Sykes, 1992). Likewise, post-combustion of coal produced a lot of fly ash, bottom ash and slags, collectively known as coal combustion residue (CCRs) (Mishra, 2004). Fly ash introduced into the environment through transportation and the atmospheric mobility of fly ash over large distances, from the coal plant to the deposit and/or dumping site (Raja et al., 2015), increases its impact on both terrestrial and water creatures.

Objectives:

The specific objectives include:

1. Survey of affected villages in the vicinity of power plant.
2. To collect data on fly ash application in agriculture.
3. To examine potential health risk posed by fly ash emission.
4. To study the impact of fly ash on plants.
5. To propose mitigation Strategies and technology for monitoring environmental and health impact of fly ash.
6. Awareness and education among the local population about the potential risks associated with fly ash emissions.

Methodology:

Human Health Assessment:

A health risk assessment will be conducted among populations located in vicinity to the power plant. Especially village residents exposed to fly ash particles for long duration and with pre-existing health conditions. Assessment will be done by using door to door visit and using survey questionnaire. This will involve data collection and some functionality test and symptoms studies will also be carried out to identify potential health effects on the local population.

Phisco chemical analysis of Fly ash and Soil:

Fly ash samples will be collected from various locations around the power plant. Collected representative samples will be analyzed in laboratory using appropriate methods. Similarly Soil samples will be collected and analysis will be done by ICAR technical manual for any changes in soil properties will be determined to assess the impact of fly ash on soil quality.

Impact of fly ash on some Plant:

For this following growth parameters are considered

i) Seed germination

ii) Root and shoot length

iii) Height of the plant

iv) Fresh and dry weight

iv) Estimation of moisture, chlorophyll content

v) Estimation of essential elements like ca, mg, k, p, and ‘s’ from plants.

Operational work plan:

First Year plan: During first year plan first six month will be given for the review of literature. Remaining six month will be utilized for finalization of study area (i.e. villages) and sampling sites.

Second Year plan: During second year plan actual visits, survey, data collection and sample collection will be done.

Third Year plan: During third year plan health risk assessment and plant analysis will be done.

Fourth Year plan: During fourth year plan tabulation of data, expression of result.

Fifth Year plan: In last year writing thesis, evaluation and submission work will be done.

International status: Research on the environmental and health impacts of fly ash from thermal power plants, including Parli Thermal Power Plant, has gained significant international attention in recent years. Many countries around the world have been investigating the effects of fly ash on the environment, public health, and the overall well-being of communities. This research is particularly relevant due to the increasing demand for energy and the subsequent rise in thermal power generation, leading to greater volumes of fly ash being produced.

Numerous international studies have highlighted the potential risks associated with fly ash, which contains a range of heavy metals, trace elements, and other potentially harmful substances. These studies have examined the dispersion of fly ash in the air, plants, soil, and water, and its potential to contaminate ecosystems, affect aquatic life, and enter the food chain.

Researchers and organizations from different countries have collaborated to develop strategies for managing and mitigating the negative impacts of fly ash. International conferences, workshops, and forums have been conducted to share knowledge, best practices, and technological advancements in fly ash management and environmental protection.

National Status:

At the national level, research on the environmental and health impacts of fly ash from thermal power plants has also gained significant attention, including in the context of Parli Thermal Power Plant. As India continues to experience rapid industrialization and urbanization, the generation of fly ash has increased substantially, raising concerns about its potential effects on local communities and ecosystems.

The Indian government, through agencies like the Central Pollution Control Board (CPCB) and the Ministry of Environment, Forest and Climate Change (MoEFCC), has taken steps to address the challenges posed by fly ash. Regulations and guidelines have been established to encourage the safe disposal and utilization of fly ash, such as its incorporation into construction materials. Researchers

across the country have conducted studies to assess the quality of fly ash, its impact on soil fertility, water contamination, and potential health risks to nearby populations.

Furthermore, collaborations between research institutions, universities, and industry stakeholders have contributed to a better understanding of the challenges posed by fly ash. Efforts have been made to develop sustainable solutions, innovative technologies, and policies to manage fly ash effectively, reducing its adverse effects on both the environment and human health.

Significance: This research will contribute valuable information to the understanding of the environmental and health impacts of fly ash from thermal power plants. The findings can guide policymakers and industries in implementing effective measures to mitigate the negative effects of fly ash on human health, plants and soil quality in similar settings.

References:

Fly ash consists of fine and powdery particles that can be a source of water pollution but it also contains plant macro-nutrients (N, P, K, Ca, Mg and S) and micro-nutrients (B, Co, Cu, Fe, Mn, Mo, Ni and Zn) essential for plant growth (Plank and Martens, 1973; Sharma and Kalra, 2006). However, fly ash also contains metal(loid)s such as Al, Cr, Pb, Hg, Ni and As which are toxic to plants and animals (Sharma and Kalra, 2006; Dzantor et al., 2015). How fly ash application to soil would influence plant growth and element accumulations in plants remains unclear.

Fly ash has been used as a soil ameliorant in agricultural fields for several decades (Adriano et al., 1978; Gupta et al., 2002; Nayak et al., 2015). Fly ash application often enhances soil nutrients and plant nutrient uptake, and increases the biomass of crops and crop yields (Ram et al., 2006; Ram et al., 2007; Aggarwal et al., 2009; Thind et al., 2012; Ukwattage et al., 2013). For example, Nayak et al. (2015) demonstrated that the rice grain and straw yield in the greenhouse are significantly increased by applying up to 20% of fly ash.

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Even though fly ash application increases plant nutrient uptakes, it may lead to metal(loid)s accumulations in plants (Gupta et al., 2002). The presences of relatively high concentrations of trace elements, such as As, B, Cd, Cr, Ni, Mo and Se, are mostly observed with fly ash application to soil (Sharma and Kalra, 2006;

Manoharan et al., 2007). For example, Lee et al. (2006) reported high B concentration of 55 mg kg^{-1} in rice under the 120 t ha^{-1} fly ash application, but no B toxicity in rice was observed.

Application of fly ash to soil may influence plant biomass, soil pH and elements concentrations of plants (Gupta et al., 2002; Basu et al., 2009; Singh et al., 2010; Nayak et al., 2015). This meta-analysis showed the fly ash application overall decreased plant productivities, but increased soil pH and most elements concentrations of plants. The decrease of biomass by 15.2% under fly ash application was different from previous reviews (e.g., Singh et al., 2010) that found positive effects of fly

S. Jala *et al.*Fly ash as a soil ameliorant for improving crop production - a review
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